Memo

To: John Ramaley, RPF 2504
Staff Chief – HQ Forest Practice

From: George “YG” Gentry, RPF 2262

cc: Eric K. Huff, RPF 2544
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Date: April 19, 2025

Re: Appraisal of stump diameter to DBH

John:

Per previous conversations, here is my research on stump diameter relationships to diameter breast height. I would be happy to follow up with you should the need arise.

This paper applies to second growth and younger trees generally. Old growth is a separate category and owing to wide variation in taper and bark thickness and requires an experienced cruiser to apply it judiciously.

George D. Gentry

RPF 2262

MGMT 5(c)

Appraisal of stump diameter to DBH

Conifers

In the present case, the Forest Resilience Exemption, this issue is greatly simplified as we are investigating younger trees, and primarily the 30 to 36-inch DBH classes for the purposes of enforcement and compliance. Because we are focused on a narrow range of diameters, and tree form is somewhat consistent in younger trees, the problem is greatly simplified.

Obtaining stump diameter

Stump cruising is well established in the field of appraisal for timber trespass and timber theft cases. For compliance purposes, determining DBH from stump diameter can take several approaches, borrowing from these techniques**.**

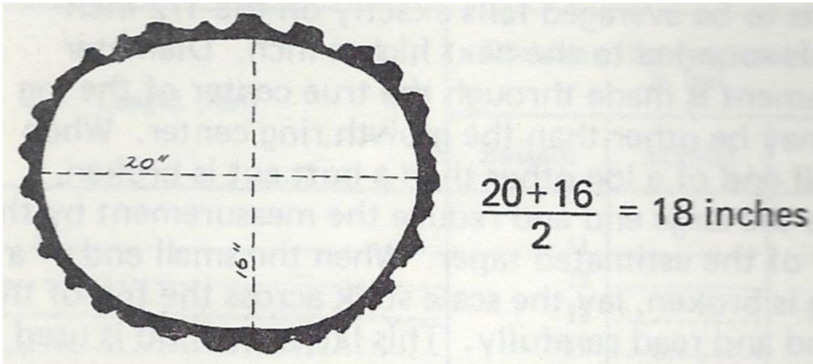
1. **Rule of thumb**

   A common approach, useful for rapid assessment, is to equate stump dib to DBH. In general, this approach presumes that stump dib is the same as DBH. Thus, a 28-inch stump dib equates to a 28-inch DBH. Some argue that this measure is inexact, but they are primarily arguing that from the viewpoint of volume estimation, where small difference might mean significant volume differences.

   This approach is useful because it is a reasonable approximation and will provide quick vetting of the situation. If the dib at stump height exceeds 30 inches- say dib is 32- then it is certain that the DBH is larger than the limit of 30.

   The drawback is that stump height will vary, so a low stump height will result in a bias to larger projected DBH verses a high stump. Then too, a stump that isn't level will do the same if not corrected for. In general, this approach should be sufficient in the 1 to 1.5 foot stump height range.

   Stump measurement should be obtained by a minimum of two measurements. This requires as level a measurement as possible over the stump. Two measurements are needed using the apparent "widest" diameter and averaging it with the "narrowest" diameter.



If the stump does not have an obvious wide or narrow quality, the widths can be obtained by designating predetermined cardinal directions to remove any bias, e.g., one taken North-South, one taken East-West. Again- these should be as level as possible. If they are laid directly along the stump a “slope distance” effect can be introduced that produces inaccuracies.

This raises the issue of accurate measurements. No perfectly exact measurement of these dimensions can really be obtained, so some latitude must be introduced. In the field, for DBH, a common approach is 2-inch diameter classes. I would suggest in this case, rounding to the nearest half inch could be an approach.

If the comparative analysis below is to be used, then these additional steps will be required:

Clear debris (e.g., sawdust, branches) around the stump to access the base and top edge.

Standard Reference Point: Measure from the ground level (base of the stump, typically at the soil surface) to the top of the cut surface. A standard stump height is often assumed to be 1 foot, but actual heights vary.

Account for Ground Slope: On sloped terrain, measure from the uphill side of the stump to ensure consistency, as the downhill side may appear taller. Alternatively, average the height from multiple sides.

Precision: Measure to the nearest inch, depending on your needs.

Consider Saw Kerf: If evaluating timber loss, account for the thickness of the saw cut, which may add 0.5–2 cm to the effective stump height.

Stump Diameter: Measure the diameter at stump height outside bark (DOB) and inside bark as outlined above.

2. Comparative Analysis- Field crosscheck

Another approach, in conjunction with the "Rule of Thumb" approach, is to examine remaining trees in the stand. If the initial scan with "Rule of Thumb" indicates that there is a potential for exceeding the prescribed DBH, then further examination via this approach is useful.

Since the exemption requires increasing QMD, it follows that there should be sufficient trees remaining in DBH classes close to the limit or slightly above the limit of 30. After DBH is obtained, stump diameter outside bark can be measured and compared to observable stumps for any correlation. Stump diameter outside bark should be obtained at a height consistent with the observed stumps in the harvest area.

Again, the forester must use professional judgement to ensure the trees measured in this manner are close approximations of the harvested trees. The same approach for accuracy as outlined above should suffice.

3. Existing Ratio or Tables

Yet another approach is established ratios or tables constructed from field observations. Many of these can be found in the SAF Handbook or other locations. They are somewhat useful, although they primarily exist for eastern species.

Table 27. Ratio of Dbh to Stump Diameter Inside Bark, by Species, West Coast

Species	Ratio	Standard error of the estimated ratio	Trees (number)	Average dbh (in)	Range of dbh's (in)
Ponderosa pine	0.987	0.005	223	29.0	10.7–53.1
Douglas fir (east side)	1.006	.023	105	22.6	11.0–39.9
Douglas fir (west side)	1.021	.010	59	29.6	11.3–47.3
Western larch	1.003	.012	55	18.6	9.8–28.9
Lodgepole pine	.937	.012	28	14.2	9.6–22.7
White fir	1.014	.011	27	24.9	13.0–43.0
Subalpine fir	.865	.025	17	13.7	10.9–18.8
Englemann spruce	.832	.010	14	13.5	9.0–25.2

Source: J. R. Dilworth. 1980. Log scaling and timber cruising. Oregon State University Book Stores Inc., Corvallis, Oregon.

Stump Diameter to DBH – 2nd Growth Douglas-fir

Stump Diameter (in)

Stump Ht (ft)	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
0.5	3.2	4.0	4.7	5.5	6.3	7.1	7.9	8.6	9.4	10.2	11.0	11.8	12.5	13.3	14.1	14.9	15.6	16.4	17.2	17.9	18.7
1	3.4	4.3	5.1	6.0	6.8	7.7	8.5	9.4	10.2	11.1	11.9	12.7	13.6	14.4	15.3	16.1	16.9	17.8	18.6	19.4	20.2
1.5	3.6	4.5	5.4	6.3	7.2	8.0	8.9	9.8	10.7	11.6	12.5	13.4	14.2	15.1	16.0	16.9	17.7	18.6	19.5	20.3	21.2
2	3.7	4.6	5.5	6.5	7.4	8.3	9.2	10.1	11.0	11.9	12.9	13.8	14.7	15.6	16.5	17.4	18.3	19.2	20.1	20.9	21.8
2.5	3.8	4.7	5.7	6.6	7.5	8.5	9.4	10.3	11.3	12.2	13.1	14.1	15.0	15.9	16.9	17.8	18.7	19.6	20.5	21.4	22.4

For further review of tables, please see the SAF Handbook, pages 281-287.

4. Allometric and Regression Equations

The above information is sometime used to develop equations exist in the general form of:

DBH= a + b (Stump dib)

where a and b are constants determined through examination, at a specified stump height.

These equations are useful if there is a sufficient sample of trees to create the equation, and they have applicability to the species and region involved.

D.b.h. and stump diameter relationships for young-growth conifers,
Challenge Experimental Forest

SPECIES	CONSTANTS OF THE D.B.H.-STUMP DIA. REGRESSION EQUATIONS[a]		COLUMN C[b]	COLUMN D[c]	STD. ERROR OF ESTIMATE	SAMPLE BASIS			
	A	B				No. of Trees	Avg. d.b.h.	Range of d.b.h.	Range of Stump d.i.b.
Ponderosa pine	-0.30625	1.00784	63.4	.9927	1.402	61	27.7	11.9-47.4	12.3-49.8
Sugar pine	0.50682	0.94638	71.5	.9923	1.218	82	28.0	12.0-48.4	12.0-52.3
Douglas fir	-0.92870	1.06029	37.5	.9773	2.127	68	30.5	12.0-48.6	11.4-49.0
Incense cedar	-1.80074	1.11149	38.3	.9726	1.562	86	21.1	12.1-40.0	12.0-34.6
White fir	-0.07417	1.01448	50.1	.9854	1.475	77	22.6	11.7-50.7	11.4-51.2

[a]Where:
D.b.h. = A + B (Stump d.i.b.)
[b]Column C - Calculated "t" value for regression coefficient.
[c]Column D - Correlation coefficient.

This results in tables like the one below:

Estimated d.b.h. for given stump d.i.b., mixed conifers[a]

PONDEROSA PINE

STUMP DIB	DBH	95% CONFIDENCE INTERVAL	STUMP DIB[b]	DBH	95% CONFIDENCE INTERVAL
in.	in.		in.	in.	
12.0	11.8	11.2 - 12.4	32.0	31.9	31.6 - 32.3
13.0	12.8	12.2 - 13.4	33.0	33.0	32.6 - 33.3
14.0	13.8	13.2 - 14.4	34.0	34.0	33.6 - 34.4
15.0	14.8	14.3 - 15.4	35.0	35.0	34.5 - 35.4
16.0	15.8	15.3 - 16.3	36.0	36.0	35.5 - 36.4
17.0	16.8	16.3 - 17.3	37.0	37.0	36.5 - 37.4
18.0	17.8	17.4 - 18.3	38.0	38.0	37.5 - 38.5
19.0	18.8	18.4 - 19.3	39.0	39.0	38.5 - 39.5
20.0	19.9	19.4 - 20.3	40.0	40.0	39.5 - 40.5
21.0	20.9	20.4 - 21.3	41.0	41.0	40.5 - 41.6
22.0	21.9	21.5 - 22.3	42.0	42.0	41.4 - 42.6
23.0	22.9	22.5 - 23.3	43.0	43.0	42.4 - 43.6
24.0	23.9	23.5 - 24.3	44.0	44.0	43.4 - 44.7
25.0	24.9	24.5 - 25.3	45.0	45.0	44.4 - 45.7
26.0	25.9	25.5 - 26.3	46.0	46.1	45.4 - 46.7
27.0	26.9	26.5 - 27.3	47.0	47.1	46.4 - 47.8
28.0	27.9	27.6 - 28.3	48.0*	48.1*	47.3 - 48.8
29.0	28.9	28.6 - 29.3	49.0*	49.1*	48.3 - 49.8
30.0	29.9	29.6 - 30.3	50.0*	50.1*	49.3 - 50.9
31.0	30.9	30.6 - 31.3			

5. USDA modeling

The USDA has developed a "Timber Theft Program". The Timber Theft Program is designed to help the user predict standing tree volumes from stumps using regression analysis in a timber theft case. It is distributed free of charge and can be downloaded from the Forest Management Service Center web site:

https://www.fs.usda.gov/forestmanagement/products/measurement/tools/timbertheft/index.php

This program allows the user to develop various regression models, eventually leading to volume development. It can be used to calculate DBH as well, but requires careful execution in the development of dependet variables and regression fit.

Hardwoods

The same techniques can be utilized as outlined above for hardwoods- e.g. rule of thumb and comparative analysis. There are tables that reflect stump to DBH relationships in the SAF handbook, pages 281-287.

Since hardwoods often grow a "multi-stem" configuration, however, the stump needs to be examined for multiple piths. The stump may be actually the result of two or more trees growing together.

Bibliography

Beck, James A., Jr.; Teeguarden, Dennis E.; Hall, Dale O. 1966. Stump diameter--d.b.h. relationships for young-growth mixed conifer species. California Forest and Forest Products. 44: 6 p.

Zeibig-Kichas, N.E., Ardis, C.W., Berrill, J., & King, J.P. (2016). Bark Thickness Equations for Mixed-Conifer Forest Type in Klamath and Sierra Nevada Mountains of California. *International Journal of Forestry Research, 2016*, 1-10.

Curtis, R. O., Arney, J. D.., Pacific Northwest Forest and Range Experiment Station (Portland, O., United States. Forest Service. (1977). *Estimating D.B.H. [diameter at breast height] from stump diameters on second-growth Douglas-fir.* Portland, Or.: Dept. of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station.

K. F. Wenger, “Forestry Handbook,” Second Edition, Society of American Foresters, John Wiley & Sons, New York, 1984, 1335 p.

Hann, D. W. (1976). *Relationship of stump diameter to diameter at breast height for seven tree species in Arizona and New Mexico*. Dept. of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station.

James A. Westfall, Ronald E. McRoberts, An assessment of uncertainty in volume estimates for stands reconstructed from tree stump information, *Forestry: An International Journal of Forest Research*, Volume 90, Issue 3, May 2017, Pages 404–412,